

Improved Efficiency of Intact Crop Removal for Broiler Breeder Rooster and Hen Carcasses During Manual Evisceration

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Primary Audience: Processing Line Supervisors, Equipment Manufacturers, Poultry Processing Researchers

SUMMARY

By using a technique that previously demonstrated improved efficiency of intact crop removal for broilers, experiments were conducted to determine the effectiveness of the technique in 40- and 41-wk-old broiler breeder roosters and hens. The technique involved (after scalding, defeathering, and head removal) separating (breaking) the neck from the carcass parallel with the shoulders and leaving the ventral neck skin, trachea, and esophagus intact. With an individual carcass suspended by its wings from a shackle, the esophagus was grasped above the proventriculus within the thoracic cavity, and the crop was pulled through the thoracic inlet. The maximum load required to remove the crop from the carcass was recorded, and it was determined if the crops removed were intact or ruptured. Carcasses that had the neck broken prior to crop removal had significantly more crops removed intact (85%, 35 of 40) for both rooster and hen carcasses compared with only 20% removed intact (8 of 40 carcasses) for rooster and hen carcasses in which the neck remained unbroken. The load required to remove the crop was influenced by gender and treatment. Rooster carcasses required a higher load (5.7 kg) than hen carcasses (4.9 kg), and for rooster carcasses, breaking the neck prior to evisceration resulted in a lower load (5.2 kg) to remove the crop than that of carcasses in which the neck remained unbroken (6.2 kg). The difference (0.2 kg) in the load recorded for crops removed intact and those that ruptured was not significant and suggests that crops ruptured during removal resulted from external attachments and not to inherent weakness. Breaking the neck of broiler breeder carcasses prior to evisceration improved the efficiency of intact crop removal (85% removed intact) and would thereby minimize the incidence of crop contents contaminating the carcass during evisceration.

Key words: crop removal, broiler breeder, evisceration, neck breaker

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DESCRIPTION OF PROBLEM

Raw poultry meat has been identified as one source of the foodborne human pathogens

Salmonella spp. and *Campylobacter jejuni* [1, 2, 3]. It has been reported that broiler carcasses can become contaminated with bacteria by contact with ingesta or feces from the alimentary

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tract during grow-out, transport to the processing plant, holding at the processing plant, or evisceration [4, 5, 6, 7]. Leakage of crop contents has raised concern with a rupture rate of 26% reported for a commercial broiler processing plant [5]. Both *Salmonella* and *Campylobacter* have been recovered from the crop of broilers at the time of processing [4, 6, 7]. The crop can potentially act as an internal reservoir for contamination during processing, since it is likely that during evisceration, leakage of crop contents may occur. If evisceration could be accomplished without rupture of the crop or leakage of its contents, then the carcass bacterial level should remain at the pre-evisceration level.

Previous experiments evaluated alternative methods for crop removal from 6-wk-old broiler carcasses, and the application of neck breakage at the shoulders prior to evisceration resulted in a 97% incidence of crops removed intact compared with 88% for carcasses in which necks remained attached [8]. The current study was conducted to determine if neck breaking prior to evisceration would also be beneficial for improving the incidence of intact crop removal from the carcasses of broiler breeder roosters and hens.

MATERIALS AND METHODS

Breeders

Forty broiler breeders at 40 and again at 41 wk of age were obtained from a flock raised in an environmental-type laying house at the University of Georgia. The afternoon prior to each processing day, 20 roosters (BW between 4.1 and 5.4 kg) and 20 hens (BW between 4.0 and 4.6 kg) were selected, leg banded, placed into coops (5 per coop), and transported to the University of Georgia pilot processing plant. Breeders had been fed a standard mash laying diet (149 g for each hen and 115 g for each rooster) at 0600 h the morning of cooping. An overnight feed withdrawal period was chosen to provide adequate time for clearance of the alimentary tract and would be considered typical for processing of spent breeder roosters and hens.

Processing Procedures

Four roosters or hens per batch (5 batches per gender per day) were suspended in shackles

by their feet and stunned using a brine stunner set at 18 V pulse direct current (500 Hz) for 12 s [9]. Stunned breeders were killed by severing both carotid arteries and the right jugular vein (leaving the trachea and esophagus intact) and then bled for 120 s. Carcasses were scalded at 55.6°C (132°F) for 120 s in a single-tank commercial scalding and defeathered using a single-pass picker for 30 s [10]. After defeathering, heads were removed with hand shears prior to evisceration.

Evisceration and Crop Removal

The experiment consisted of 2 treatments applied prior to manual evisceration: 1) the neck remained attached or 2) the spinal column and neck muscles were broken and sheared parallel to the shoulders, and the neck and skin stretched about 5 cm with care taken not to damage the trachea, esophagus, or crop. Neck breaking was accomplished using a Jarvis DNB1 hand-held pneumatic neck-breaker that was set at 620 kPa (90 psi) for hen carcasses and 827 kPa (120 psi) for rooster carcasses [11].

The abdominal cavity was opened from the end of the keel to the vent, and the heart was removed to permit grasping of the thoracic esophagus above the proventriculus with the thumb and forefinger. Each carcass was hung by the wings in a shackle suspended from a scale that was tared. The esophagus was slowly pulled by hand straight down until the crop was either removed from the carcass intact or ruptured. After removal, the crop was examined and determined to be intact or ruptured. The maximum load, as indicated by the scale, was recorded [12]. Breeder roosters and hens were processed in groups of 4 (2 for each treatment) with rotation of treatments and genders to minimize effects of cooping time and processing order (a maximum of 2 h).

Statistical Analysis

Body weight and maximum load data were analyzed using the general linear model procedure of SAS software [13]. Sources of variation in the model included the main effects of pre-evisceration treatment (2), gender (2), and replication day (2). The percentage of intact and

TABLE 1. Pre-evisceration neck-breaking effect on the incidence of intact crop removal (number/total) and the maximum load (kg) for broiler breeder rooster and hen carcasses

Parameter	Rooster carcasses		Hen carcasses	
	Neck attached	Neck broken	Neck attached	Neck broken
Incidence of intact crop removal				
Number	5/20	18/20	3/20	17/20
Percentage	25	90	15	85
Maximum load, kg				
Crop intact	6.38	5.34	6.15	5.10
Crop ruptured	6.18	4.34	4.55	4.72
Pooled SEM	0.10			
BW at cooping, kg				
Crop intact	4.45	4.81	4.40	4.23
Crop ruptured	4.96	5.09	4.22	4.37
Pooled SEM	0.39			
Sources of variation–probability, <i>P</i>	% Intact	Maximum load	BW	
Gender	0.7714	0.0066	0.0001	
Treatment	0.0023	0.0224	0.1283	
Condition (intact or ruptured)	—	0.0511	0.0287	

ruptured crops was analyzed using the chi-squared test of independence. Pearson product-moment correlation coefficients were determined between BW and maximum load.

RESULTS AND DISCUSSION

The number and percentage of broiler breeders from which the crop was removed intact during manual evisceration are presented in Table 1. Significantly more crops were removed intact following neck breaking (85 and 90%) for both hen and rooster carcasses than for carcasses that were eviscerated with the neck attached (15 and 25% intact). The percentage of crops removed intact did not differ

significantly between rooster and hen carcasses, *P* = 0.7714. These results are comparable with those reported for 6-wk-old male broilers in which 97% of the crops were removed intact when the pre-evisceration neck-breaking technique was used [8]. In that study, broilers eviscerated after the head was removed resulted in 88% of the crops removed intact. In contrast for breeder carcasses, when the head was removed prior to evisceration, in only 25% of rooster and 15% of hen carcasses were the crops removed intact. This low incidence of crops removed intact from breeder carcasses (when necks remained attached) suggests there are stronger external attachments to the crop

TABLE 2. Pearson product-moment correlation between BW and maximum load (kg) for rooster and hen carcasses subjected to pre-evisceration neck breaking or not and for crops that were removed intact or ruptured

Parameter	Rooster carcasses		Hen carcasses	
	Neck attached	Neck broken	Neck attached	Neck broken
Crop intact				
<i>r</i>	0.2917	0.4352	−0.9821	0.4680
<i>P</i>	0.6339	0.0710	0.1208	0.0581
Crop ruptured				
<i>r</i>	0.4039	— ¹	0.2968	0.4522
<i>P</i>	0.1354	—	0.2474	0.7013

¹Insufficient number (2 of 20) of rooster carcasses with ruptured crop for the calculation of a correlation. No significant correlations were detected (*P* > 0.05).

to overcome during evisceration of breeders than for 6-wk-old broilers. The high incidences of intact crops removed in both broilers and breeders (85 to 97%), when evisceration was preceded by neck breaking, indicates that the technique appears valid and should be considered for implementation in commercial processing plants.

Values for the maximum load obtained during removal of crops from broiler breeder carcasses are also shown in Table 1. A significantly greater load was required to remove crops from rooster carcasses (5.7 kg) than from hen carcasses (4.9 kg) by 0.82 kg. The maximum load to remove the crop was lower from carcasses that had the neck broken prior to evisceration by 0.37 kg. For those crops that were removed intact, carcasses that had the neck broken had a 16 to 17% lower maximum load than carcasses with the neck attached. The application of these maximum load values obtained during manual evisceration of breeder carcasses may not be directly extrapolated to commercial processing, which occurs at a rapid and automated rate. However, neck breaking prior to evisceration should lower the load required to remove the crop from the carcass in most situations, since several attachments to the external surface of the crop are removed during the neck-breaking procedure.

The maximum load required to remove the crop from breeder carcasses was higher by 2 kg than the values we reported for 6-wk-old broiler carcasses (2.9 kg for female and 3.7 kg for male carcasses), and the values for maxi-

mum load to remove the crop continued to exceed BW values [14, 15]. Body weight averaged 4.8 kg for roosters and 4.2 kg for hens and did not differ between assigned treatment groups. However, BW at cooping was slightly greater ($P = 0.0287$) for breeders in which the crop ruptured during removal than for those in which the crop was removed intact. However, the 70-g difference in weight represents about 1.5% of BW at cooping and therefore may not be of practical importance. We previously concluded that for broilers from 5 to 8 wk of age, BW was increasing at a faster rate than the maximum load required to remove the crop from the carcass [15]. This trend appears to have continued to be true for the 40- and 41-wk-old, feed-limited broiler breeders in which BW was 2.65 kg greater than 6-wk-old broilers, and the maximum load to remove the crop was only 2 kg greater than for 6-wk-old broilers. Correlations between BW and maximum load were not significant for broiler breeder hens or roosters (Table 2). The absence of a significant correlation between BW and the maximum load to remove the crop indicates that for mature broiler breeders within the weight range of 4.0 to 5.4 kg, the load required to remove the crop from the carcass is independent of BW. In contrast, for 6-wk-old broilers, a positive correlation ($r = 0.45$ to 0.54) was found between BW and the maximum load required to remove the crop intact, indicating the greater importance of BW uniformity among treatment groups for broilers [8].

CONCLUSIONS AND APPLICATIONS

1. Significantly more crops were removed intact from broiler breeder hen and rooster carcasses during manual evisceration following neck breaking (85 and 90%) compared with evisceration of carcasses with the necks attached (15 and 25%).
 2. Significantly less maximum load (16.5%) was required to remove intact crops from hen and rooster carcasses when the neck was broken prior to evisceration.
 3. The maximum loads for crops that ruptured during evisceration were not significantly different between carcasses that had the neck broken or those that remained attached.
 4. Based on this study, the efficiency of manual extraction of the crop intact from broiler breeder rooster and hen carcasses was greatest when neck breaking preceded evisceration.
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